TrackPlot Enhancements: Support for Multiple Animal Tracks and Gyros

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LONG-TERM GOALS

The long term goal of this work is to create software to support the visualization and kinematic analysis of marine animal movements derived from archival tag data. Tags are supported that have sensors for pressure, acceleration, magnetics and optionally, rotations. The software will create pseudotracks and these may be georeferenced given appropriate georeferencing information. With the use of gyros dynamic accelerations may be computed and visualized.

OBJECTIVES

Add capabilities to TrackPlot software to improve kinematic analysis and simplify the analysis of data from multiple tags simultaneously deployed.

1) Support for the analysis of gyroscopes data in combination with accelerometer and magnetometer data.
2) the extraction and frequency analysis of accelerations and rotation in animal coordinates, providing support for the analysis of kinematic patterns from tag data;
3) support for the visualization and kinematic analysis of foraging groups
4) support for longer tag deployments,
5) enhanced support for the presentation of results

WORK COMPLETED

- Field work was carried out in June 2015, in the Stellwagen Humpback tagging project (Chief Scientist David Wiley). In this project we deployed Acousondes (from Susan Parks), and CATS tags from Jeremy Goldbogen. One of the Acousondes had a fastLoc GPS. Taking advantage of this, a new method for georeferencing a psudo-track has been developed and incorporated into TrackPlot.
- On one day of the Stellwagen cruise we successfully deployed three tags on animals in a single group. This will provide useful test data for the implementation of multi tag support in TrackPlot.

- TrackPlot can now be used to process the new CATS tag data.
- The bulk of the effort so far in 2015 has been devoted to processing tag gyroscope data from OpenTag. Most of this work has been done with tags attached to Steller and California sea lions, since the PI has been unsuccessful in obtaining data from smaller cetaceans (because of inaccuracies in the gyros and accelerometers, it is only possible to resolve larger dynamic accelerations signals).

RESULTS

Most of the previous years' effort was the development of gyro method to obtain true dynamic acceleration. This year we greatly improved the analysis of these data and as a result have developed a new metric APBA (averaged propulsive body acceleration). Figure 1 shows forward acceleration and estimated speed from a Steller sea lion swimming at approximately 8.5 kph.

Our method allows us to estimate time averaged thrust from data such as that in Figure 1 using the equation

$$\langle T \rangle_{tf} = \frac{(APBA)(M_{animal} + M_{entrained})}{\left(1 - {t_s}/{t_f}\right)}$$

Where APBA is the propulsive acceleration averaged over a stroke-glide cycle. M_{animal} is the mass of the animal and $M_{entrained}$ is the mass of entrained water, t_s it the duration of a stroke and t_f is the stroke to stoke period.

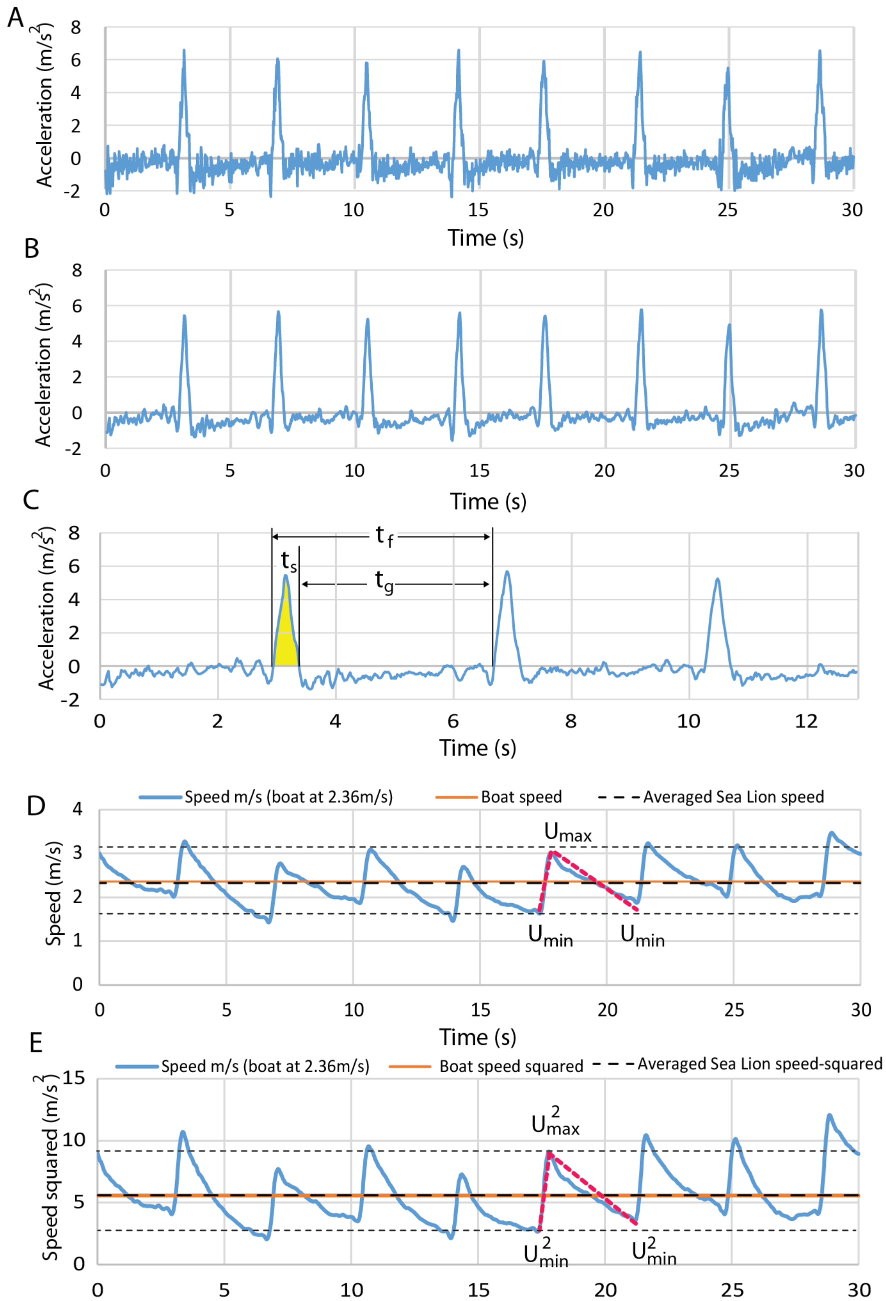

Figure 1. A series of strokes from an animal swimming at approximately 8.5 kph. A) 50 Hz forward acceleration. B) Smoothed to 10 HZ. C) The area under the curve in the interval t_s is the gain in speed from a stroke. The glide duration is t_g and the duration of an entire stroke-glide cycle is t_f. D) Speed obtained by integrating the smoothed data. The model is indicated by the red dashed line. E) Speed squared from the same data. Horizontal dashed lines represent the averaged MIN and MAX speeds

TrackPlot now supports the display of dynamic accelerations. Figure 2 shows an ascent by a tagged California sea lion with the forward component of dynamic acceleration plotted. This work will be the subject of a poster at the Marine Mammal Conference.

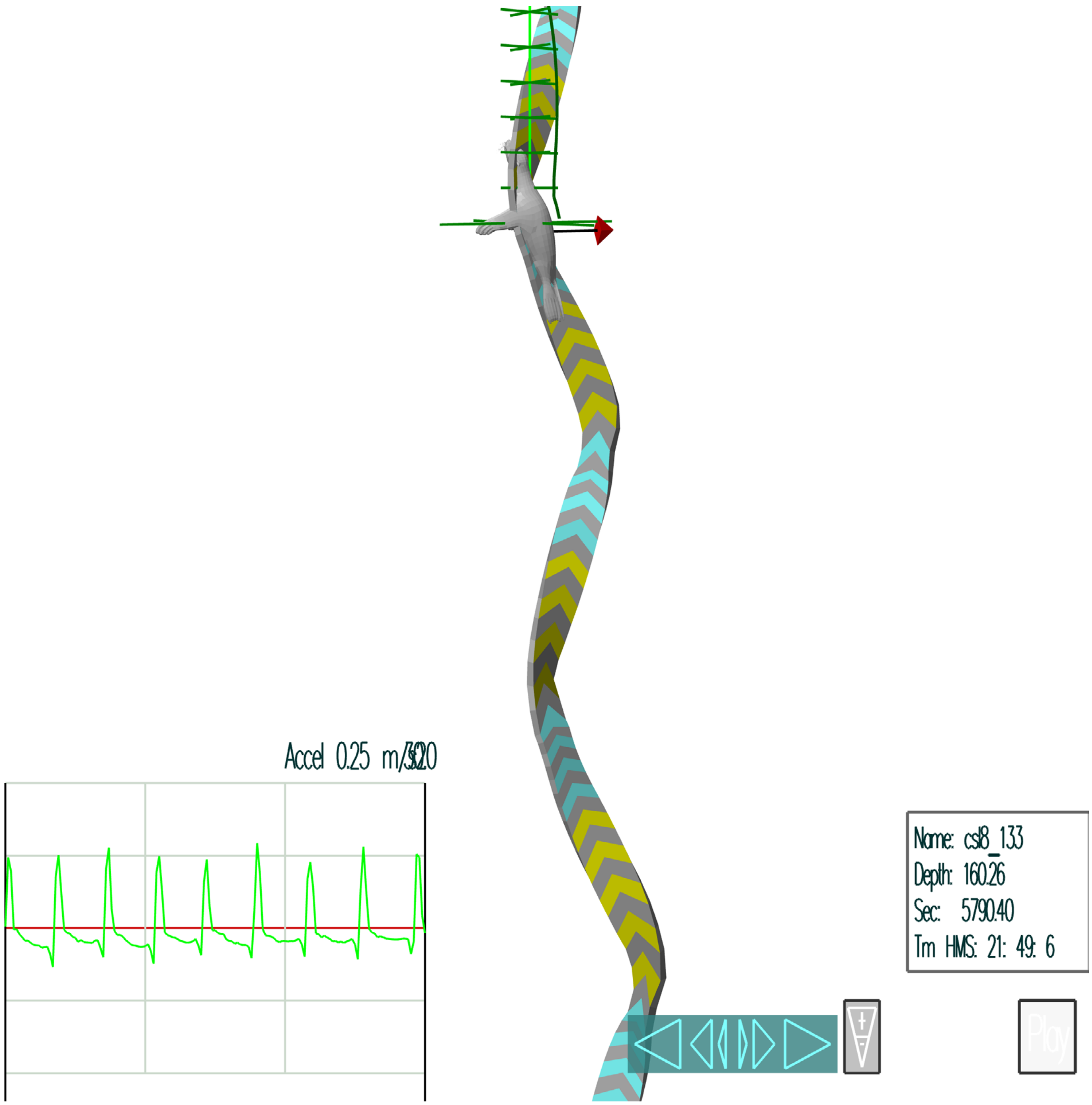

Figure 2. A portion of an ascent by a California sea lion shown in TrackPlot. This illustrates an alternating left-right stroke pattern. The plot to the lower left shows forward accelerations. Each spike represented a flipper stroke.

Georeferencing

For the first time Ware was able to acquire fast-loc gps data having a reasonable quality (from one of Susan Parks Acousondes with a piggy backed fast-loc). This created an immediate demand for better georeferencing facilities within trackPlot. A new capability has been implemented and this is

illustrated in Figure 3. The method involves a weighted average that takes into nearest K fixes (nine works well), to generate a local pseudo-current (similar to the method developed by Johnson). For these data the results are consistent with the 0.5 kt northerly current observed at the location east of Cape Cod. The result is a pseudo track retaining the natural movement quality of a non-georeferenced track. Nevertheless because of effects such as crabbing, it may be better to use a non-georeferenced track for interpretation. Once a georeferenced track has been created TrackPlot can print out georeferenced locations for events such as lunges if they have been identified.

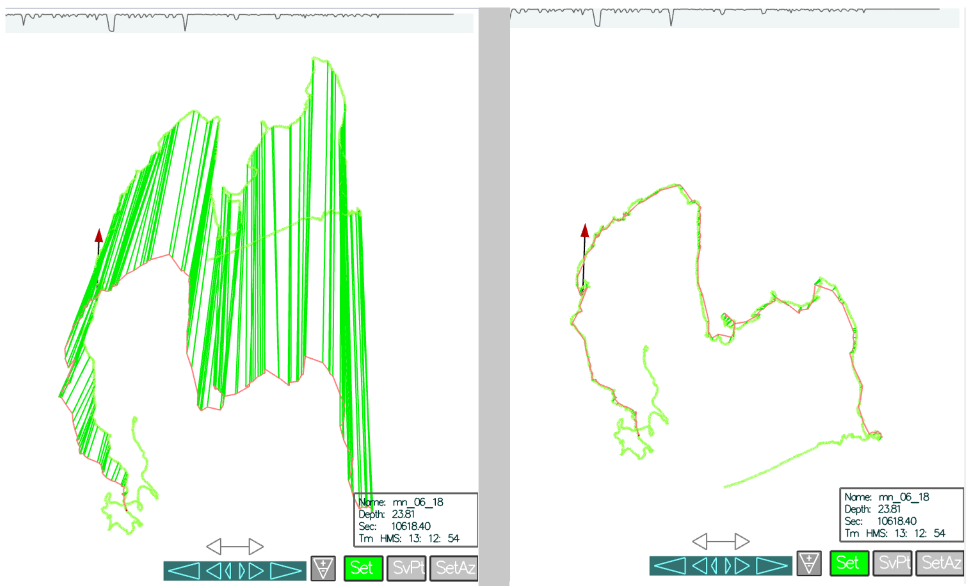

Figure 3. The trackPlot pseudo-track creation interface is shown. On the left the green line shows the pseudo track from dead reckoning. The red line connects fast-loc gps fixes. On the right is the geo-referenced track. The discrepancy between the dead reckoning and the fixes is consistent with a 0.5 kt current flowing north.

Support for multiple tracks: On one day of the (Wiley et al) Stellwagen in June 2015, we successfully deployed three tags on animals in a single group. There were two OpenTags and one CATS tag. This will provide test data for the implementation of multi tag support in TrackPlot.

This development is currently underway, but it will involve a somewhat tricky refactoring of the code; a robust new version of TrackPlot supporting the display of multiple Tag data should be available some time in 2016.

Major Problems/Issues
TrackPlot use is being mainly hindered from the number of tags of different types being deployed, and the lack of common data formats and calibrations. Even for a single tag type there are often differences between one tag and another as they evolve. For example several of the open tags have gyros which record double the actual animal rotation rate. Discovering and remedying these problems has been extremely time consuming.

Current evidence suggests that the instrument package for these tags is not sufficiently accurate to get true accelerations from the fluking of large whales, but it likely can for dolphins, pinnipeds

However, obtaining suitable data from cetacean deployments has challenging. . Data from tagged dolphins would be ideal, but a planned deployment in Florida fell through (A planned collaboration with Tyack). I am expecting soon to receive data from a CATS tag deployment on some smaller cetacean, such as a pilot whale from Jeremy Goldbogen

This is the first full year of the project which only started in mid 2014. Very little of the funds were expended in 2014 due to the date when funding became available and a no cost extension will be requested.

TECHNOLOGY TRANSFER

No current technology transfer to report.

PRODUCTIVITY

No current product outputs to report. A new release of TrackPlot (TrackPlot3.0) is now available.

AWARD PARTICIPANTS

Dr. Colin Ware

REFERENCES

Ware, C., Trites, A., Rosen, D. and Potvin, J. (resubmitted with new co-author) Relating propulsive body acceleration to swimming speed and hydrodynamic drag for Steller sea lions using tags incorporating gyroscopes and accelerometers